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AUTHOR Williams, Robert T.
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ABSTRACT

This paper reports on an analysis of the shortage of mathematics teachers in North Carolina. It was found that: (1) The effects of the shortage fell on the remedial math students, general math students in high school, and seventh and eighth grade classes; (2) The percentage of new math teachers among all new secondary teachers has declined; (3) The number of reported vacancies has been declining; and (4) In most years, the number of new math teachers graduated exceeded the number of vacancies. It is commonly recognized that many math education graduates choose employment outside of the schools. A discussion is presented on certification policies, incentives, and the institution of penalties for out-of-field teaching, particularly for those mathematics teachers who are teaching subjects other than their own specialty. (JD)

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THE TRAINING, AVAILABILITY, CERTIFICATION, AND ASSIGNMENT OF SECONDARY SCHOOL MATHEMATICS TEACHERS

Robert T. Williams

Presented at the Annual Meeting of the American Association of Colleges For Teacher Education (AACTE), February 19, 1981

The theme for this annual meeting is "Excellence in Education." This paper speaks to the first of the five categories under that theme: The Quest for Quality in Schools. My presentation will show how the nationwide shortage of mathematics teachers has affected one state. I will take the position that teacher educators, especially those in an area of shortage, have a responsibility to work to change conditions in the political sector of education, such as certification policies, incentives, and the institution of penalties for out-of-field teaching.

There is strong consensus that the most important in-school quality factor is the classroom teacher. Researchers throughout the nation have spent untold hours in analyzing the teaching process, the interaction between teacher behavior and student responses, and in developing valid instruments and techniques for measuring teacher effectiveness. We have made significant progress in all of these areas. My concern today is with a much simpler issue: The teacher cannot teach material that he/she does not know. I suspect that both the general public and many educators are not aware of the extent to which schools are using teachers out-of-field.

Teacher certification systems are based on the rationale that a teacher must possess (among other things) knowledge of subject matter, that is to say, mathematics teachers ought to have a substantial knowledge of mathematics. Our teacher education programs accept this rationale, resulting in the academic major component of our curricula. However, a strong academic major will not help public school children if our graduates neither go into teaching, nor if our graduates are assigned classes in subjects other than their major.

Although the shortage of mathematics teachers has been well documented for many years, there seems to be no serious effort to alleviate it. We cannot even assume that the shortage is widely known. Just before last November's election, I had occasion to mention to a candidate for statewide office that I was doing a study on this shortage. His reply was, "Is there a shortage?"

Frequent articles in the news media report the overall national surplus of teachers, but fail to point out that the surplus does not apply to all specialties, or they don't mention this until the later paragraphs. Because citizens have been bombarded by so many societal problems, they have become insensitive to general calls for change. Unless the message gets through in a personal way--the direct effects on their pocketbook, their health, or their children--it is likely to get lost.

Does the following North Carolina pattern apply to your state? Throughout each school year, occasional publicity is given to the mathematics teacher shortage. In April and May, when college seniors apply to school districts for

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positions, they are frequently told, "We have no openings now." In July, principals and personnel officers report mathematics teacher vacancies, with not enough candidates to fill those vacancies. It is clear that by mid-August the principal's concern is quite specific: get a body into every classroom. In North Carolina, there are no contracts or laws which inhibit the principal when making teaching assignments, other than to hire a teacher who holds some certificate. It becomes a matter of finding the best person available.

Three strategies are frequently used to cover math teacher vacancies: 1) to reassign a non-mathematics teacher already on the staff; 2) to split a math teaching load among several teachers; and 3) to hire a new faculty member who is not certified in mathematics. Miraculously by September 15, there is someone assigned to every classroom. The public reaction has to be, "The shortage must not be very serious."

This past December, personnel people in three of our larger school districts were quoted in the press to the effect that the math and physical science teacher shortage had forced them to get replacements, but the problem wasn't serious yet. And the cycle continues. My data show that in these school districts there were 10, 23, and 62 persons teaching math last year who were not certified in math. When does a situation become a problem? If the administrators who are directly involved don't admit to having a problem, then chances are diminished for facing and solving that problem. There is no monetary penalty to the teacher or to the school for out-of field teaching. There is no requirement that next summer the temporary solution must be undone when a certified math teacher becomes available.

As a result of several years of making do with those who were available, last year North Carolina school districts employed over 2,000 teachers of mathematics who were not certified in math. This was 45% of all those who taught math in grades 7 - 12. 441 of these teachers taught a full schedule of mathematics. I have compiled the data by school district and by school.

The teachers of secondary remedial mathematics are of special interest. These positions were created during the past four years as one component of North Carolina's accountability/competency program. The filling of these math positions introduced a new dimension to the shortage. Of the 445 teachers who were assigned one or more classes or remedial math last year, 69 per cent were not certified in mathematics. This has prompted the question. "Would a doctor refer his toughest cases to a specialist or to a general practitioner?"

We had 202 secondary schools with no certified math teacher on the faculty. Although many of these schools were small, 15 of them were large enough to justify a full-time math position. In addition to these schools with no teacher certified in math, there were many junior highs and middle schools where a student could register for Algebra I without ever having been taught by a teacher certified in math.

A tally of those teaching each of the 33 math courses listed in the state's inventory was made. The 33 courses were then grouped into four categories:

1. junior high/middle school courses;
2. algebra I;
3. high school general math courses; and
4. high school college preparatory courses.

It was clear that the large majority of college-prep students were being taught math by teachers who were certified in math. The effects of the shortage of certified math teachers fell on the remedial math students, on those who are taking general math courses in high school, and those in seventh and eighthgrade math classes. The data do not show whether this sorting also exists between sections of seventh and eighth grade classes. It is quite possible that where these students are tracked, the teachers of the stronger students are more likely to be certified in math. Is it merely a coincidence that the children of the citizens most likely to speak out have a high proportion of properly certified teachers?

A response which frequently pops up about now is "Let's beef up the teacher education enrollment and crank out more graduates." That would be helpful. But the supply-demand relationship for mathematics teachers is affected by the number of vacancies, the production of new teachers, their hiring rate, and their retention in the classroom.

Each year North Carolina colleges and universities send to the State Department of Public Instruction reports of completions in teacher education. Also, the superintendent of each school district sends in a vacancy count, e.g., so many unfilled mathematics teacher openings. Math teacher positions which are filled by teachers not certified in mathematics are not considered openings. Beware: national survey data may well be based on this type of response at the local level.

An analysis of these reports for the last 20 years reveals the following: 1) the per cent of new mathematics teachers as a fraction of all new secondary teachers declined steadily since 1967; 2) the number of reported vacancies for math teachers has been declining since 1969; and surprisingly 3) in most years, the number of new math teachers graduated exceeded the number of vacancies.

The hiring rate is a second factor on the supply side. The same reports reveal that in none of the 20 years were more than 58 per cent of the prior year's graduates actually teaching in the fall. The lowest for any one year was 40 per cent. The data do not show how many graduates started teaching in subsequent years, nor taught for a while, left the classroom, and subsequently returned to the classroom. If we could substantially increase the hiring rate, we would not need to increase enrollment so much.

The third factor is retention in the classroom. It is commonly recognized that many mathematics teachers (and new math education graduates) choose other employment. "Industry is hiring our people!" What is not commonly recognized is that although some of these people are attracted by substantially higher salaries in industry or government, many remain in school work in other capacities. For example, 464 persons who were employed in a N.C. school last year were certified in mathematics, but were not teaching mathematics. The two largest groups were teaching other subjects or serving as principals, with

proper certification. But 90 were serving in positions for which they were not certified. Add to this, other former math teachers who are employed in school district offices, state departments, and colleges, and we have a sizeable group who contribute to the shortage of mathematics teachers. Although some of these are fully involved in mathematics supervision or in math education, they are not classroom teachers in grades 7 - 12. Had many of these stayed in the classroom, the shortage would be greatly reduced. Clearly the shortage of math teachers cannot be attributed solely to low college enrollments in teacher education. But at the same time, a successful response to this shortage would counteract our other problem: declining enrollment.

While processing the data which led to the numbers cited above, certain patterns and lack of patterns became apparent. For example, there was much variety across schools regarding the way principals had set up master schedules, in the selection of courses to be taught, and in the mis-match between the certificates which teachers held and the courses to which they were assigned. The notes I took resulted in a list of 35 policy and procedures questions which have yet to be answered. Some of these questions are:

1. Why are teachers who are certified in the shortage areas of physics and chemistry teaching junior high science and math (this was one of many similar cases)?
2. Why does a principal assign a math teacher to two social studies classes and also assign a social studies teacher to two math classes (this was one of many similar cases)?
3. For secondary remedial students, is the teacher's knowledge of subject matter more, or less, important than the teacher's interactive style?
4. Would research data support our belief that in most cases students will learn more math from teachers who are certified in math than from teachers who are not certified in math?
5. When vacancies occur, to what extent do principals and personnel directors give priority to moving out-of-field teachers into their area of certification?
6. To what extent has out-of-field teaching contributed to the decline of SAT scores and other quality measures?
7. How much of the blame directed at teacher education institutions is attributable to our graduates being assigned to teach classes out-of-field?
8. What actions can be taken at the local and state levels to reduce the amount of out-of-field teaching?
9. What incentives can be offered to increase the supply of teachers into fields of shortage?

While it is necessary to document a shortage problem quantitatively, this is not sufficient. One must also learn the reasons behind the data: why a policy or procedure was changed; who pushed for the change and who resisted it; what beliefs and attitudes people have about the issue you are investigating; and whether they consider it to be a problem or just a situation.

Your state may not have a math teacher shortage. Instead, the shortage may be in physical science, or vocational education, or some facet of special education. Regardless of the subject, I take the position that teacher educators--especially those in the area of shortage--have a leadership responsibility for reducing that shortage. This means getting involved in the political process which affects decision-making. The following 11 strategies cut across subject matter fields and can be used by teacher educators to affect decisions in any state:

1. Define the problem clearly, specifically, and quantitatively;
2. List the groups which have allowed the problem to develop, and determine their awareness of and attitude towards the problem;
3. List those individuals and groups who would be most supportive of solving the problem;
4. Identify a few of them to start communicating with;
5. Develop a database to be used as an awareness mechanism;
6. Disseminate information to support groups through their professional meetings, journals and newsletters, and your personal contacts with their leaders;
7. Identify those individuals and groups who would be most resistant to solving the problem, and determine whether it's best to ignore them or to develop strategies to neutralize them;
8. Develop a list of alternative solutions to the problem, and make these available for discussion;
9. Identify the few key persons or groups who can effect the desired changes;
10. With leaders from your support groups, develop strategies for getting the attention of the key persons and for tying your objectives to their objectives; and
11. Feed the key persons a mixture of support and pressure until the decisions are made.

All of this must be done with a sensitivity to external conditions and timing. When a conservative fiscal atmosphere is prevailing, don't expect salary increases to be supported as a means to attract more people into teaching. When teacher unions are strong, don't expect a salary differential proposal to get very far, as a means to hold math teachers in the classroom.

In North Carolina, the external conditions and timing appear to be favorable for some action which will reduce the teacher shortage in both mathematics and physical science. Whether all the necessary elements for accomplishing this will coalesce remains to be seen. The initiative was set in motion 25 years ago when the governor announced creation of the Research Triangle Park as an industry-hunting lure. Industry-hunting has been a priority for state government ever since. As the new industries have grown in numbers and sophistication, they have provided an alternative employment opportunity to math teachers and to new math education graduates. The growth of the community college system, state government, and the university system all had a similar effect on the availability and retention of math teachers.

The present governor, who was just re-elected to a second four-year term, pushed through several new education programs in his first term, and earned the reputation of being a strong education supporter. He has recently announced

the acquisition of several micro-electronics industries and the formation of a microelectronics research center at North Carolina State University. The possibilities for a further drain on the stock of available math teachers are at hand.

Concurrently, several independent events occurred which have since merged into a force that may reverse the shortage. In November 1979, the science division of the state education agency published a 26-page science teacher profile in which it was noted that 29% of the teachers of science in grades 7-12 were not certified in science. Last March the Government Relations Committee of the N. C. Council of Teachers of Mathematics sent a one-page resolution to the governor, the legislature, state education leaders, and local school superintendents. The governor's copy was hand-carried to him by a committee member. This booklet, the March resolution, and my availability and interest resulted in my initiating this work in April. In June, two faculty members from our Department of Mathematics and Science Education published a newspaper article which was carried statewide, in which their graphs dramatically showed the drop in new teacher completions in math and science.

By August, the resolution had resulted in the formation of a committee to study the shortage problem. This committee was not in the education establishment, but was responsible to the N. C. Board of Science and Technology, which reports to the governor. The governor's concern for high-technology industry had been translated into a need for high school graduates with a stronger background in mathematics and science, who could qualify for employment in those industries. This concern to meet political and industrial needs was then translated into a need for reducing the math and science teacher shortage, as a key factor in upgrading public school programs and graduates. Five teacher educators have participated in the past year's events, but at no time did they meet together to formulate a plan. Four of them are on this committee.

The study committee has split into three subcommittees. I am on the one considering incentives (financial and non-financial) to attract more people into teaching mathematics and physical science, and also incentives to keep them in the classroom. Our most recent report was a laundry list of over 50 incentives targeted to different groups, ranging from attracting more high school seniors into math and physical science teacher education through the recruitment of persons who retire early from other occupations. The full committee will respond to this list in the next two weeks. I will make copies of this draft list available to any of you who would like one. You might also want to get a copy of The Second Mile Plan, which describes incentives adopted by the Houston, Texas Independent School District.

Several of the committee members have made commitments to speak of the committee's work at the state school boards' association meeting, the summer superintendent's conference, and to other pertinent groups. A data book is being prepared for dissemination and to be used as a resource guide for speakers. There is talk of holding a Governor's Conference on Science and Mathematics in the Schools.

We don't know where all this is headed, or how long the external conditions will be favorable. It's possible that no more than five or ten of the incentives will be adopted, or that only one or two policies will be changed. But that

may be all that it takes to reverse the mathematics teacher shortage. It's satisfying to see teacher educators play leadership roles in activities which could strengthen public school instruction throughout the state in a relatively short time. I challenge you to identify a problem in your speciality area which is related to a policy or practice in the elementary and secondary schools of your state, and to set to work to solve that problem.

I have purposely left time for discussion and questions. Some of you may wish to react to a point made from the audience as the discussion moves along. I call your attention to the audience reaction sheets scattered throughout the room, and request that you complete one. You may leave them on your chair or at the end of the row. Thank you.